J/ψ production in Au+Au/Cu+Cu collisions at $\sqrt{s}_{NN}$=200 GeV and the threshold model

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Using the QGP motivated threshold model, where all the J/ψ's are suppressed above a threshold density, we have analyzed the preliminary PHENIX data on the centrality dependence of nuclear modification factor for J/ψ's in Cu+Cu and in Au+Au collisions, at RHIC energy, $\sqrt{s}_{NN}$=200 GeV. Centrality dependence of J/ψ suppression in Au+Au collisions are well explained in the model for threshold densities in ranges of 3.6-3.7 fm^{-2}. J/ψ suppression in Cu+Cu collisions on the other hand are not explained in the model.

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I. INTRODUCTION

In relativistic heavy ion collisions J/ψ suppression has been recognized as an important tool to identify the possible phase transition to quark-gluon plasma. Because of the large mass of the charm quarks, $c\bar{c}$ pairs are produced on a short time scale. Their tight binding also makes them immune to final state interactions. Their evolution probes the state of matter in the early stage of the collisions. Matsui and Satz [1], predicted that in presence of quark-gluon plasma (QGP), binding of a $c\bar{c}$ pair into a J/ψ meson will be hindered, leading to the so called J/ψ suppression in heavy ion collisions [1] . Over the years, several groups have measured the J/ψ yield in heavy ion collisions (for a review of the data prior to RHIC energy collisions, and the interpretations see Refs. [2, 3]). In brief, experimental data do show suppression. However, this could be attributed to the conventional nuclear absorption, also present in pA collisions.

In recent Au+Au collisions at RHIC, one observe a dramatic suppression of hadrons with high momentum, transverse to beam direction (high p_T suppression) [4, 5, 6, 7]. This has been interpreted as evidence for the creation of high density, color opaque medium of deconfined quarks and gluons [8]. It is expected that high density, color opaque medium will leave its imprint on J/ψ production. At RHIC energy, it has been argued that rather than suppression, charmoniums will be enhanced [9, 10]. Due to large initial energy, large number of $c\bar{c}$ pairs will be produced in initial hard scatterings. Recombination of $c\bar{c}$ can occur enhancing the charmonium production. PHENIX collaboration have measured the centrality dependence of J/ψ invariant yield in Au+Au collisions at RHIC energy, $\sqrt{s}_{NN}$=200 GeV [11, 12]. More recently they have improved upon the statistics and preliminary results for the centrality dependence of nuclear modification factor (R_{AA}) for J/ψ in Au+Au collisions and in Cu+Cu collisions are available [13, 14]. In most central Au+Au collisions, J/ψ's are suppressed by a factor of $\sim$ 3. PHENIX data on J/ψ production in Au+Au/Cu+Cu collisions, are not consistent with models which predict J/ψ enhancement [9, 10]. It was also seen that various models, e.g. comover model [15], statistical coalescence model [16] or the kinetic model [17], fail to explain the (preliminary) PHENIX data on the nuclear modification factor for J/ψ in Cu+Cu and in Au+Au collisions. The data are also not explained in the Glauber model of normal nuclear absorption [19]. Recently, in a QCD based nuclear absorption model , we have analyzed the preliminary PHENIX data on J/ψ suppression in Cu+Cu and in Au+Au collisions [20]. In the QCD based nuclear absorption model [21, 22], $c\bar{c}$ pair, during its passage through a nuclear medium, gain relative 4-square momentum. Some of the pairs gain enough to cross the open charm threshold and are lost. The model explained the PHENIX data on the centrality dependence of J/ψ suppression in Cu+Cu collisions at RHIC but failed for Au+Au collisions. It was concluded that in Au+Au collisions, J/ψ are suppressed in a medium, unlike that produced in SPS energy nuclear collisions or at RHIC energy Cu+Cu collisions. If in Au+Au collisions, J/ψ's are suppressed in a deconfined matter, PHENIX data should be explained in a QGP motivated model, like the threshold model [23, 24]. Blaizot et al [23, 24], proposed the threshold model to explain the NA50 data on anomalous J/ψ suppression in 158 AGeV Pb+Pb collisions at SPS energy [25] . To mimic the onset of deconfining phase transition above a critical energy density and subsequent melting of J/ψ's, J/ψ suppression was linked with the local energy density. If the energy density at the point where J/ψ is formed, exceeds a critical value (ε_c), J/ψ's disappear.

In the present paper, in the threshold model, we have analyzed the preliminary PHENIX data on the centrality dependence of J/ψ suppression in Cu+Cu and in Au+Au collisions. As it will be shown below, while the centrality dependence of J/ψ suppression in Au+Au collisions are well explained in the model, that in Cu+Cu collisions are not. We have also analyzed the PHENIX data on the centrality dependence of p_T broadening of J/ψ [13, 14].

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No definitive conclusions can be obtained from the p_T broadening data .

The plan of the paper is as follows: in section II, we briefly describe the threshold model. PHENIX data on the centrality dependence of J/ψ suppression are analyzed in section III. In section IV, we analyze the PHENIX data on p_T broadening of J/ψ. Summary and conclusions are drawn in section V.

II. THRESHOLD MODEL

The details of the threshold model could be found in [23, 24]. It is assumed that fate of a J/ψ depend on the local energy density, which is proportional to participant density. If the energy density or equivalently, the participant density, exceeds a critical or threshold value, deconfined matter is formed and all the J/ψ's are completely destroyed (anomalous suppression). This anomalous suppression is in addition to the "conventional nuclear absorption". Transverse expansion of the system is neglected. It is implicitly assumed that J/ψ's are absorped before the transverse expansion sets in.

In the threshold model, number of J/ψ mesons, produced in a AA collision, at impact parameter $\mathbf{b}$ can be written as,

$$\begin{aligned} \sigma^{J/\psi}_{AA}(\mathbf{b}) = \quad & \sigma^{J/\psi}_{NN} \int d^2\mathbf{s} T^{eff}_A(\mathbf{s}) T^{eff}_B(\mathbf{b}-\mathbf{s}) \\ & \times S_{anom}(\mathbf{b},\mathbf{s}), \end{aligned} \tag{1}$$

where $T^{eff}(b)$ is the effective nuclear thickness,

$$T^{eff}(\mathbf{b}) = \int_{-\infty}^{\infty} dz \rho(\mathbf{b},z) exp(-\sigma_{abs} \int_z^{\infty} dz\prime \rho(\mathbf{b},z\prime)), \tag{2}$$

σ_{abs} being the J/ψ-Nucleon absorption cross-section. $S_{anom}(\mathbf{b},\mathbf{s})$ in Eq.1 is the anomalous suppression factor introduced by Blaizot *et al.* [23, 24]. Assuming that all the J/ψ's get suppressed above a threshold density (n_c), the anomalous suppression can be written as,

$$S_{anom}(\mathbf{b},\mathbf{s}) = \Theta(n(\mathbf{b},\mathbf{s}) - n_c) \tag{3}$$

where n_c is the critical or the threshold density. $n(\mathbf{b},\mathbf{s})$ is the local transverse density. At impact parameter $\mathbf{b}$ and at the transverse position $\mathbf{s}$, local transverse density it can be obtained as,

$$\begin{aligned} n(\mathbf{b},\mathbf{s}) = \quad & T_A(\mathbf{s})[1 - exp(-\sigma_{NN} T_B(\mathbf{s}-\mathbf{b}))] \\ & + T_B(\mathbf{b}-\mathbf{s})[1 - exp(-\sigma_{NN} T_A(\mathbf{s}))] \end{aligned} \tag{4}$$

Blaizot *et al* [23, 24] fitted the NA50 data [25] on the transverse energy dependence of J/ψ suppression in 158 AGeV Pb+Pb collisions and obtain the threshold density n_c. With J/ψ-nucleon absorption cross-section $\sigma_{J/\psi N}$=6.4 mb, NA50 data are well explained in the model with n_c=3.7 fm^{-2}. Better fit to the data is obtained if the theta function (Eq.3) is smeared, at the expense of an additional parameter. Later experiments [26] indicate that J/ψ-nucleon absorption cross-section is $\sim$ 4 mb, rather than 6.4 mb. NA50 collaboration also revised their data [27]. The revised NA50 data were also analyzed in the threshold model [28]. With $\sigma_{abs} \sim 4$ mb, large smearing of the threshold density is required. Large smearing of threshold density, effectively excludes formation of deconfined matter at SPS energy.

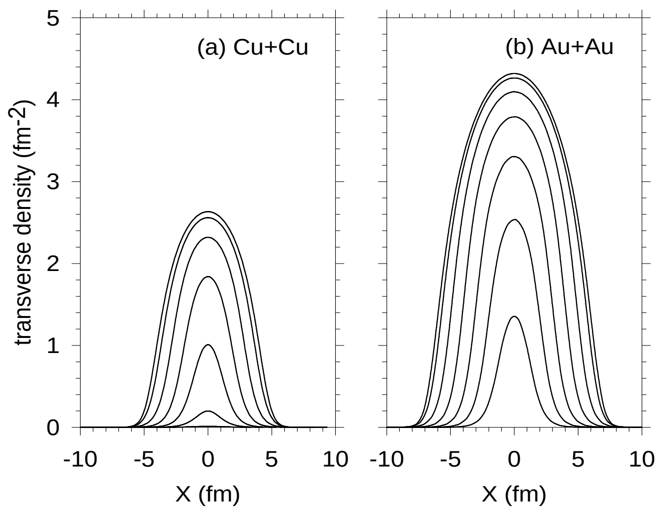

FIG. 1: Transverse density in Cu+Cu (left panel) and in Au+Au (right panel) collisions, for various values of the impact parameter, b=0,2,4.... (from top to bottom). The origin is at a distance, $d = b/(1 + R_A/R_B)$ from the center of the nucleus A.

III. J/ψ SUPPRESSION IN CU+CU/AU+AU COLLISIONS

In the threshold model, fate of a J/ψ is determined on the local (transverse) density. If the local (transverse) density exceeds the threshold density, J/ψ's are completely destroyed. In Fig.1, for a number of impact parameters, the transverse density, $n(\mathbf{b},\mathbf{s})$ in Cu+Cu and in Au+Au collisions are shown. We have used the Woods-Saxon form for the density,

$$\rho(r) = \frac{\rho_0}{1 + exp((r-R)/a)}, \qquad \int d^3 r \rho(r) = A \tag{5}$$

with R=4.456 (5.415) fm and a=0.54 (0.535) fm, for Cu (Au) nuclei.

For central collisions, maximum transverse density in Cu+Cu collisions is $\sim$2.63 fm^{-2}, while that for Au+Au

collisions is $\sim 4.32\ fm^{-2}$. Then if J/ψ's are anomalously suppressed, say, above a threshold density, n_c=3.7 fm^{-2}, J/ψ suppression in Cu+Cu collisions will not be affected as the transverse density never exceeds the threshold density. In Au+Au collisions, on the other hand, J/ψ's will be anomalously suppressed. In Au+Au collisions also, only in collisions where local density $n(\mathbf{b},\mathbf{s})$ exceeds the threshold density, J/ψ's will be anomalously suppressed. In all other collisions, J/ψ's will be absorbed only due to J/ψ-nucleon interaction. Then if J/ψ suppression is measured as a function of impact parameter or equivalently, as a function of centrality of collisions, sudden change of slope will be observed.

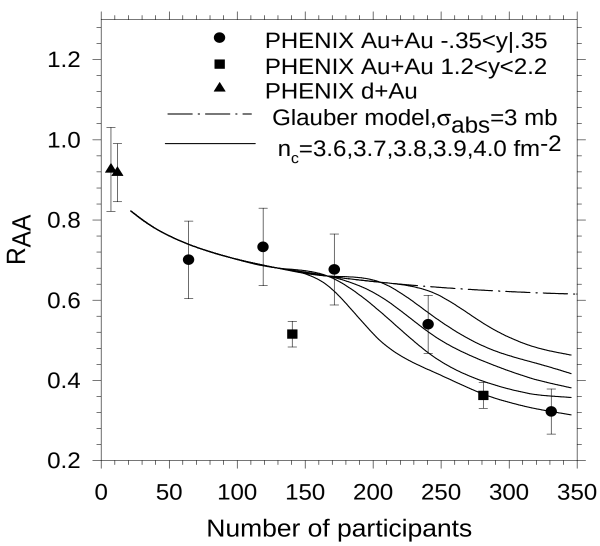

FIG. 2: Preliminary PHENIX data on the participant number dependence of nuclear modification factor (R_{AA}) for J/ψ, in Au+Au collisions. R_{AA} for J/ψ in d+Au collisions are also shown. The dashed line is the Glauber model prediction for R_{AA} with σ_{abs}=3 mb. The solid lines (bottom to top) are the threshold model predictions for threshold density, n_c=3.6,3.7,3.8,3.9 and 4 fm^{-2}.

Such a sudden change of slope in J/ψ suppression is observed by the PHENIX collaboration in Au+Au collisions. In Fig.2, preliminary PHENIX data on the centrality dependence of nuclear modification factor (R_{AA}) for J/ψ, in Au+Au collisions are shown [13, 14]. PHENIX collaboration has taken data in two ranges of rapidity intervals, (i) $-0.35 \leq y \leq 0.35$ and (ii)$1.2 \leq y \leq 2.2$. Both the data are shown. Even though data points are few, sudden change of slope of R_{AA} around $N_{part} \sim 150$ is evident. PHENIX data for R_{AA} in d+Au collisions are also shown in the Figure. J/ψ's are suppressed in d+Au collisions also. Glauber model analysis indicate that in d+Au collisions, J/ψ-nucleon absorption cross-section is small, $\sigma_{abs} \approx 1-3$ mb [19]. In Fig.2, prediction for R_{AA}, in the Glauber model of normal nuclear absorption is shown as the dash-dot-dashed line. The prediction is obtained with σ_{abs}=3 mb. It is interesting to note that the Glauber model of nuclear absorption, with σ_{abs}=3 mb, explains the suppression in peripheral and mid-central collisions. Only in very central collisions, the Glauber model of nuclear absorption model predict much less suppression than observed by the PHENIX collaboration. Anomalous suppression in Blaizot's threshold model can provide the additional suppression required in very central collisions. Due to paucity of data, we do not attempt to fit the PHENIX data and extract the threshold density, n_c. Rather, for a number of threshold density, n_c=3.6,3.7,3.8,3.9 and 4.0 fm^{-2}, we obtain predictions for R_{AA} in the threshold model. In Fig.2, solid lines are the predictions in the threshold model. With anomalous suppression, J/ψ's are strongly suppressed in central collisions and it is evident that for threshold density in the ranges of 3.6-3.7 fm^{-2}, the threshold model describe the data adequately well.

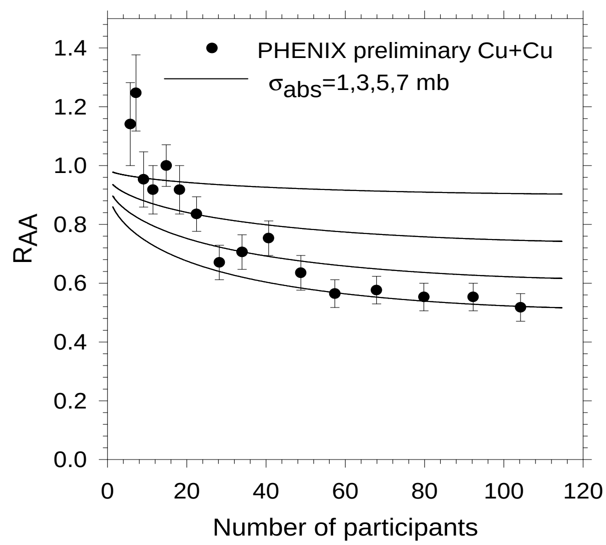

FIG. 3: Preliminary PHENIX data on the centrality dependence of nuclear modification factor (R_{AA}) for J/ψ in Cu+Cu collisions. R_{AA} for J/ψ in d+Au collisions are also shown. The solid lines (top to bottom) are Glauber model predictions with σ_{abs}= 1,3,5 and 7 mb.

We now analyze the PHENIX data on the centrality dependence of nuclear modification factor, in Cu+Cu collisions. The data are shown in Fig.3. We have not distinguished between the mid-rapidity and forward rapidity data. In contrast to Au+Au data, R_{AA} in Cu+Cu collisions do not show any sudden change in slope. Threshold model, which induces sudden change in slope, is not warranted by the data. Indeed, if the threshold density is in the ranges of 3.6-3.7 fm^{-2}, anomalous suppression will be ineffective in Cu+Cu collisions. As shown in Fig.1, maximum transverse density reached in central Cu+Cu collisions is $\sim 2.63\ fm^{-2}$, much less than the threshold density 3.6-3.7 fm^{-2}.

As mentioned earlier, J/ψ production in d+Au collisions at RHIC, require σ_{abs} $\sim$ 1-3 mb. Glauber

model predictions with σ_{abs}=3 mb, also explains the PHENIX data on the centrality dependence of J/ψ suppression in peripheral and mid-central Au+Au collisions. Only in very central Au+Au collisions, data demand anomalous suppression. However, in Cu+Cu collisions, Glauber model predictions with σ_{abs}=1-3 mb fails to explain the centrality dependence of J/ψ suppression. In Fig.3, Glauber model predictions for J/ψ suppression in Cu+Cu collisions, for various values of J/ψ-nucleon absorption cross-sections, σ_{abs}=1,3,5, and 7 mb are shown. For σ_{abs}=1-3, the model could explain suppression only in very peripheral collisions (N_{part}=10-20). In mid-central and very central collisions, the model with σ_{abs}=1-3 mb, underpredict the suppression. If the J/ψ-nucleon cross section is increased, while the model explains the mid-central and very central collisions, it fails to explain peripheral collisions. The analysis indicate that, with a single value J/ψ-nucleon absorption cross-section σ_{abs}, the Glauber model of nuclear absorption, can not explain the centrality dependence of J/ψ suppression in Cu+Cu collisions. J/ψ suppression in Cu+Cu collisions at RHIC energy is more complex than envisaged in the Glauber model of nuclear absorption. Indeed, a more complex, QCD based nuclear absorption model, does explain the centrality dependence of J/ψ suppression in Cu+Cu collisions adequately well [20].

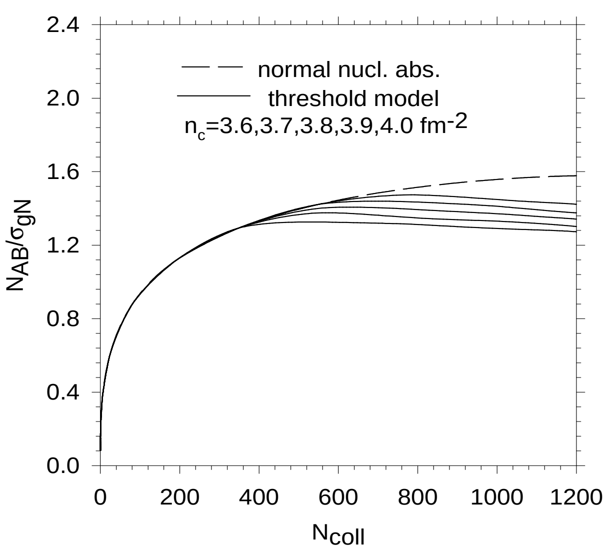

FIG. 4: Collision number dependence of the ratio N_{AB}/σ_{gN} in Au+Au collisions. The dashed line is the ratio in the normal nuclear absorption model, with σ_{abs}=3 mb. The solid lines are N_{AB}/σ_{gN} in the threshold model, with threshold density n_c=3.6,3.7,3.8,3.9 and 4.0 fm^{-2} (from bottom to top) respectively.

In the threshold model, it is implicitly assumed that J/ψ's are absorbed in a deconfined matter. The critical energy density for deconfined matter formation is proportional to the threshold density. Melting of J/ψ due to color screening is mimicked by the sudden on set of suppression. Successful description of PHENIX data on J/ψ suppression in Au+Au collisions then strongly support formation of deconfined matter in central Au+Au collisions. However, we note that the model neglects some very important effects, e.g. (i) feed back from ψ' and χ states and (ii) transverse expansion. A considerable fractions of J/ψ's are from decay of ψ' and χ states. That part is completely neglected here. Threshold density for anomalous suppression of higher states, ψ' and χ should be less than that for a J/ψ. Then presently estimated threshold density n_c=3.6-3.7 fm^{-2} represent an upper limit of the threshold density. At RHIC, model studies indicate that in the deconfined phase, the system undergoes significant transverse expansion [29]. The local transverse density is a key ingredient to the Threshold model. In an expanding system, local transverse density will be diluted. J/ψ's which are anomalously suppressed in a static system, may survive in an expanding system due to dilution. Then, the presently estimated critical density 3.6-3.7 fm^{-2} will again represent an upper limit of the threshold density.

IV. CENTRALITY DEPENDENCE OF p_T BROADENING IN CU+CU/AU+AU COLLISIONS

It is well known that in pA and AA collisions, the secondary hadrons generally show p_T broadening [30, 31]. p_T broadening of J/ψ in Cu+Cu and in Au+Au collisions at RHIC energy $\sqrt{s}_{NN}$=200 GeV, has been measured by the PHENIX collaboration [13, 14]. They measured the collision number dependence of square of transverse momentum for J/ψ. It is interesting to compare the threshold model predictions with the PHENIX data.

The natural basis for the p_T broadening is the initial state parton scatterings. For J/ψ's, gluon fusion being the dominant mechanism for $c\bar{c}$ production, initial state scattering of the projectile/target gluons with the target/projectile nucleons causes the intrinsic momentum broadening of the gluons, which is reflected in the p_T distribution of the resulting J/ψ's. Parameterising the intrinsic transverse momentum of a gluon, inside a nucleon as,

$$f(q_T) \sim exp(-q_T^2/ < q_T^2 >) \tag{6}$$

momentum distribution of the resulting J/ψ in NN collision is obtained by convoluting two such distributions,

$$f_{NN}^{J/\psi}(p_T) \sim exp(-p_T^2/ < p_T^2 >_{NN}^{J/\psi}) \tag{7}$$

where $< p_T^2 >_{NN}^{J/\psi}$=$< q_T^2 > + < q_T^2 >$. In nucleus-nucleus collisions at impact parameter **b**, if before fusion, a gluon undergo random walk and suffer N number of subcollisions, its square momentum will increase to $q_T^2 \rightarrow q_T^2 + N\delta_0$, δ_0 being the average broadening in

each subcollisions. Square momentum of J/ψ then easily obtained as,

$$< p_T^2 >_{AB}^{J/\psi} (b) =< p_T^2 >_{NN}^{J/\psi} +\delta_0 N_{AB}(\mathbf{b}) \quad (8)$$

where $N_{AB}(\mathbf{b})$ is the number of subcollisions suffered by the projectile and target gluons with the target and projectile nucleons respectively.

Average number of collisions $N_{AB}(\mathbf{b})$ can be obtained in a Glauber model [31]. At impact parameter $\mathbf{b}$, the positions $(\mathbf{s}, z)$ and $(\mathbf{b}-\mathbf{s}, z')$ specifies the formation point of $c\bar{c}$ in the two nuclei, with $\mathbf{s}$ in the transverse plane and z, z' along the beam axis. The number of collisions, prior to $c\bar{c}$ pair formation, can be written as,

$$\begin{aligned} N(b,s,z,z') = \quad & \sigma_{gN} \int_{-\infty}^{z} dz_A \rho_A(s,z_A) \qquad (9) \\ & +\sigma_{gN} \int_{-\infty}^{z'} dz_B \rho_B(b-s,z') \end{aligned}$$

where σ_{gN} is the gluon-nucleon cross-section. Above expression should be averaged over all positions of $c\bar{c}$ formation with a weight given by the product of nuclear densities and survival probabilities S,

$$\begin{aligned} N_{AB}(b) = & \int d^2s \int_{-\infty}^{\infty} dz \rho_A(s,z) \int_{-\infty}^{\infty} dz' \rho_B(b-s,z') \times \\ & S(b,s,z,z') N(b,s,z,z') / \int d^2s \int_{-\infty}^{\infty} dz \rho_A(s,z) \times \\ & \int_{-\infty}^{\infty} dz' \rho_B(b-s,z') S(b,s,z,z') \qquad (10) \end{aligned}$$

Centrality dependence of the ratio N_{AB}/σ_{gN}, in Au+Au collisions, for the threshold densities, n_c=3.6,3.7,3.8,3.9 and 4.0 fm^{-2}, are shown in Fig.4, (the solid lines from bottom to top). We also show the ratio in the normal nuclear absorption model (the dashed line). N_{AB}/σ_{gN} increases with centrality, more central the collisions, the gluons suffer more number of collisions. In normal nuclear absorption model, N_{AB}/σ_{gn} continues to increase with centrality (or collision number). However, rate of increase slows down at more central collisions. A different behavior is obtained in the threshold model. For a fixed threshold density n_c, N_{AB}/σ_{gn} exactly corresponds to normal nuclear absorption model, till a collision number N_c. Beyond N_c, N_{AB}/σ_{gN} hardly changes. It is understood. Beyond a N_c, transverse density exceeds the threshold density and J/ψ's are completely destroyed. As N_{AB} is weighted by the anomalous suppression, it hardly changes beyond that collision number.

p_T broadening of J/ψ's in AA collisions depends on two parameters, (i) $< p_T^2 >_{NN}^{J/\psi}$, the mean squared transverse momentum in NN collisions and (ii) the product of the gluon-nucleon cross-section and the average parton momentum broadening per collision, $\sigma_{gN}\delta_0$. $< p_T^2 >_{NN}^{J/\psi}$ is measured in RHIC energy p+p collisions, $< p_T^2 >_{NN}^{J/\psi}= 4.2 \pm 0.7\ GeV^2$. As gluons are not free, the other parameter, $\sigma_{gN}\delta_0$ is essentially non-measurable. Its value can be obtained from experimental data on p_T broadening of J/ψ. In SPS energy S+U/Pb+Pb collisions $\sigma_{gN}\delta_0$ is estimated as $0.442 \pm 0.056\ GeV^2$ [32]. $\sigma_{gN}\delta_0$ at RHIC energy is of interest.

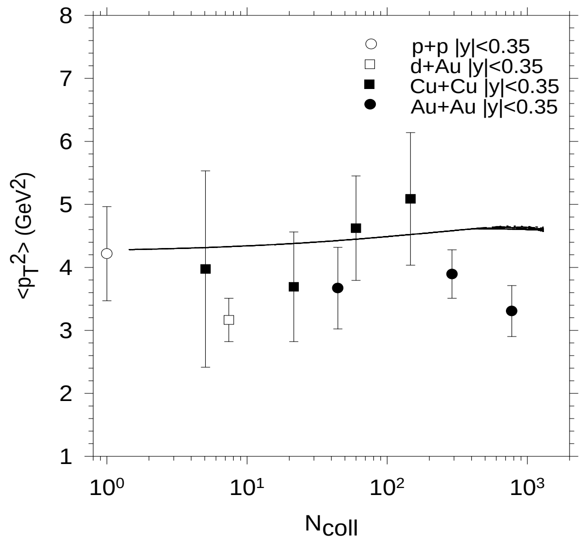

FIG. 5: J/ψ mean square transverse momentum as a function of collision number, in mid-rapidity p+p, d+Au, Cu+Cu and Au+Au collisions are shown. The solid line is the best fit, in the threshold model, to the combined Cu+Cu and Au+Au data.

PHENIX data on the centrality dependence of mean square transverse momentum $< p_T^2 >$, in Cu+Cu and in Au+Au collisions are shown Fig,5. $< p_T^2 >$ in in p+p and in d+Au collisions are also shown. Quality of data is poor, few data points with large error bars. Evidently, data do not show any evidence of p_T broadening. Within the errors, $< p_T^2 >$ in Cu+Cu and in Au+Au collisions agree with that in NN collisions. p_T broadening of J/ψ's is minimum at RHIC.

To find $\sigma_{gN}\delta_0$ at RHIC energy, we fit the combined Cu+Cu and Au+Au data set (individual Cu+Cu or Au+Au data points are few). We fix $< p_T^2 >_{NN}$ at the measured central value, $< p_T^2 >_{NN} = 4.2\ GeV^2$, and vary $\sigma_{gN}\delta_0$. $< p_T^2 >$ in Au+Au or in Cu+Cu show very little dependence on the threshold density. In Fig.5, best fit is obtained with threshold density n_c=3.6,3.7,3.8,3.9 and 4.0 fm^{-2} are shown. They can not be distinguished. Best fit is obtained with $\sigma_{gN}\delta_0 = 0.31 \pm 0.48\ GeV^2$. Due to poor quality of the data, the $\sigma_{gN}\delta_0$ is ill determined. Estimated error is larger than the central value. We conclude that PHENIX data can not determine the $\sigma_{gN}\delta_0$ at RHIC energy.

V. SUMMARY AND CONCLUSIONS

To conclude, in the QGP motivated threshold model, we have analyzed the preliminary PHENIX data on the centrality dependence of J/ψ suppression in Cu+Cu and in Au+Au collisions. In the threshold model, in addition to the normal nuclear absorption, J/ψ's are anomalously suppressed, such that, if the local transverse density exceeds a threshold density n_c, all the J/ψ's are absorped. The model predicts a sudden change of slope in J/ψ suppression as a function of centrality. Preliminary PHENIX data on the centrality (participant number) dependence of J/ψ suppression in Au+Au collisions at RHIC are well explained in the model. It also reproduces the sudden change of slope around participant number, N_{part}= 150. Estimated threshold density ranges between 3.6-3.7 fm^{-2}. PHENIX preliminary data on the centrality dependence of J/ψ suppression in Cu+Cu collisions do not show any sudden change of slope, characteristic of the threshold model. Local transverse density in most central Cu+Cu collision is only $2.63fm^{-2}$, much less than the estimated threshold density in Au+Au collisions. Anomalous suppression is not effective in Cu+Cu collisions. However, J/ψ production in Cu+Cu collisions is not explained the Glauber model of normal nuclear absorption. While very peripheral collisions require σ_{abs} ∼1-3 mb, more central collisions require σ_{abs} ∼6-7 mb. It appears that J/ψ production in Cu+Cu collisions is more complex than envisaged in the simple Glauber model of nuclear absorption. We have also analyzed the PHENIX data on p_T broadening. The quality of data is not good enough for a definitive conclusion. Apparently at RHIC energy, J/ψ's donot show any p_T broadening.

In conclusion, present analysis strongly support deconfined matter formation in central Au+Au collisions at RHIC energy $\sqrt{s}_{NN}$=200 GeV.

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